PERFORMANCE TESTING OF THE KANNE AIR FLOW-THROUGH IONIZATION CHAMBERS

Purpose

This Air Quality Group procedure describes the performance testing of the electronics on the Kanne chambers used as continuous monitors of radioactive gaseous effluent being discharged from stacks at LANSCE, TA-53.

Scope

This procedure applies to the staff member(s) or designee assigned to perform stack monitoring at TA-53 during the LANSCE run cycle as part of the radioactive air emissions monitoring project.

In this procedure

This procedure addresses the following major topics:

Topic	See Page
General Information About This Procedure	2
Who Requires Training to this Procedure?	2
Background	4
Kanne Chamber System Checks	5
Electrometer Test: LANL Model 39	7
Electrometer Test: Other Models	10
External Source Performance Test	12
Backup Battery Test: LANL Model 39	13
Records Resulting from this Procedure	15

Hazard Control Plan

The hazard evaluation associated with this work is documented in Attachment 1: Initial risk = **low**. Residual risk = **low**. Work permits required: none. First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

Signatures *(continued on next page)*

Signature	Date
Prepared by: David Fuehne, ESH-17	Date: 6/13/2000
Approved by: Scott Miller, ESH-17 Rad-NESHAP Project Leader	Date: 6/14/00
Work authorized by: Doug Stavert, ESH-17 Group Leader	Date: 6/15/00

06/22/2000

General information about this procedure

Signatures, *continued*

Approved by:	Date:
______________________________ Terry Morgan, ESH-17 QA Officer	6/14/00

Attachments

This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Hazard Control Plan	2
2	Electrometer Response Work Sheet	1

History of revision

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description of Changes
0	6/2/1993	New document, issued as HS-1/TA-53-STACK-DP-004.
1	6/21/1994	Revised to reflect new system changes, issued as ESH-1/TA-53-STACK-DP-004.
2	7/11/1995	Revised to reflect system changes and reformatted.
3	9/1/1995	Addition of step 2 requiring check of HV battery voltage and record of measured voltage on worksheet.
4	5/20/1996	Reformatted and moved to TA-53 FM document control.
5	6/20/00	Returned to ESH-17 control. Re-organized procedural steps.

Who requires training to this procedure?

The following personnel require training before implementing this procedure:

- Staff member(s) or designee assigned to perform the performance check

Annual retraining is required and will be by self-study (reading) of this procedure.

Training method

The training method for this procedure is “**self-study**” (**reading**) and is documented in accordance with the procedure for training (ESH-17-024).

Prerequisites

In addition to training to this procedure, the following training is also required prior to performing this procedure:

- -Rad Worker II, for work on potentially contaminated systems

General information about this procedure, continued

References

The following documents are referenced in this procedure:

- ESH-17-024, “Personnel Training”
- ESH-17-607, “Daily Survey of Stack Monitoring Equipment”

Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

Background

Background

This procedure tests the Kanne chamber electronics package (electrometer and pre-amplifier, if so equipped) by using a calibrated electrical current source. The procedure also checks the battery backup function, overall system functionality, and relationships between electrometer readouts and electronic data logging functions.

Frequency

Perform both tests at least twice annually, once no more than 45 days prior to beam operation to the area monitored by the Kanne chamber system, and once within 45 days after beam operation to the affected area. Additional tests can be conducted at discretion of staff. The battery backup test is only performed before beam startup.

Calibration standards

Since Kanne chambers are relative monitors, a calibrated current source is not required. However, the test is best accomplished by using a standardized current source to verify the linear response of the Kanne chambers.

Environmental factors

Environmental factors, such as temperature and humidity, could adversely affect the system. The electronics associated with the systems are only affected by 0.005% per degree centigrade so normal room temperature variations that lie between 15^{o} and 35^{o} C are acceptable. All equipment should be stored in a condensation-free environment.

Test location

Perform the electrometer tests in the field, where the system will be used. This will minimize damage to system during transport, having to disconnect and re-connect cables, sample lines, etc. Also, any area-specific factors (background radiation, etc.) will be accounted for in the test.

Warm-up

Prior to testing any electromter, be sure the electrometer has been turned ON for at least 24 hours (or other vendor-specified time length). This will allow for complete warm-up of the system, and minimize electronic drift, etc.

Kanne Chamber System Checks

Background

Regardless of electrometer type, all Kanne Chamber systems have certain items that need to be done to ensure accurate system performance.

Current Source

This procedure calls for use of a Keithley model 263 Calibrator/Current Source. If you are unfamiliar with this unit, consult an experienced user or reference the manual.

Other current sources may be used, as long as they have a valid calibration from LANL's Standards and Calibration facility.

Current values used in test

The lowest current that can be output from the Keithley 263 is 0.1 picampere (pA). This is lower than background for all the LANSCE electrometers. The electrometers should be tested, starting with 0.1 pA, and up to the full scale set-point (if equipped) or to just above the maximum current expected in the system.

The intervals used are typically 0.1 pA, 0.3, 0.5, 0.7, 1.0, 3.0, 5.0, 7.0 … This will provide several data points at each order of magnitude. Additional data points may be measured at the discretion of staff; less data points may be used if situations exist where a full-range test is not desired.

Steps to be performed

To do the system checks, perform the following steps:

Step	Action
1	Obtain an "Electrometer Performance Test Worksheet" for each Kanne chamber to be tested. A sample of this worksheet is included as Attachment 2.
2	Other equipment needed for test includes: - calibrated current source (e.g., Keithly 263) - multimeter capable of measuring at least 300 VDC - spare 300 VDC batteries, if necessary - stopwatch (for Model 39 electrometer tests only)
3	Ensure that the electrometer to be tested has been turned on for at least 24 hours prior to the electrometer test. This will provide ample time for electronics to warm up and minimize electronic drift.
4	On the worksheet, record information regarding the kanne chamber system location, equipment identification, test date, and reason for test.
5	Record on the worksheet the calibration expiration date of the current source

Steps continued on next page.

Kanne Chamber System Checks, continued

Step	Action
6	At each KC system, record the calibration expiration date of the flow nozzle and pressure gauge (if part of instrument calibration program)
7	At the top of each ion chamber, disconnect the leads between the high voltage battery and the ion chamber. Measure the battery voltage with the multimeter, and record the value on the worksheet If the battery voltage is less than 270 volts DC, replace the battery with a new one. Note the exchange and the new battery voltage in the worksheet margin or comment section.
8	Perform the test of the electrometer as described in the appropriate chapter, below. The electrometer test is somewhat different for the LANL Model 39 electrometer than for "other" model electrometers.
9	Upon completion of the electrometer test, the entire system performance can be tested with an external radiation source. This process is described in the "External Source Test" chapter.
10	If the KC system is so equipped, test the electrometer's battery backup system. Testing a LANL Model 39 battery system is described in the chapter *Backup Battery Test: LANL Model 39*. If a vendor-supplied Uninterruptable Power System (UPS) is used, similar methods should be used. Consult the manual on procedural steps to test the system. Note that this step can be conducted prior to or after the rest of the system checks. If performed after the system checks, the electrometer background should be re-verified.
11	Return to your office and transcribe the data from the worksheet into the applicable KC Performance Test spreadsheet
12	Use a linear regression function to determine the relationship between "Measured Current" vs. "Current Source output." The fit should be linear, with an "Adjusted R-Square" value of at least 0.98 (less than 2% deviation). See the section on "Acceptance Criteria," below. Note the Linearity Test pass/fail on the worksheet.
12	Upon completion of the system check, file the Electrometer Performance Test Worksheet in the Stack Gas Studies binder.

Acceptance criteria

The Kanne chamber's electrometer is considered linear and acceptable if the deviation in the data fit, using a least squares fit to a straight line, is less than 2%. If not, repeat the measurement before attempting to correct the problem. Replace the components, if possible, or completely replace the system until the current response is linear to within 2%. If the problem cannot be corrected, initiate a non-conformance or deficiency report if the test follows the beam production period.

Electrometer Test: LANL Model 39

Background

This test determines the response of the LANL Model 39 electrometers that are in the electronics package of some Kanne chamber (KC) systems.

Electrometer features

This type of electrometer, developed and constructed at Los Alamos Natinoal Laboratory by the now-defunct Electronics division, has several features not found on electrometers that are readily available from today's vendors.

First, each is equipped with a pre-amplifier to shape and boost the current signal. This allows measurements at very low current (down to 1 femtoampere, 10^{-15} amps). Current from the ion chamber immediately enters the preamp, and is then sent to the electrometer for analysis.

The "full scale" readout of each unit is adjustable from 10 pA, 100 pA, or 1 nA. The analog display meter reads out as a fraction of full scale, so at the 100 pA full scale, a reading of "0.10" indicates the electrometer is receiving a current of 10 pA [0.10 * 100 pA full scale = 10 pA]

Also, each unit has a two-channel output. Channel one is a voltage signal (0-1 VDC) which is a logarithmic output over the unit's full scale; channel 2 is a linear output (0-10 VDC) over the full scale.

The first channel (0-1 VDC) is connected to a current integrator, displaying total charge collected in the electrometer. The integrator display is in picocoulombs (pC, or 10^{-12} coulombs). Three digits are displayed at a time; to see the complete readout, the displayed digits are adjusted with a "thumb-wheel" on the electrometer front panel. Procedure ESH-17-607 has a more complete description of how to read the Model 39 integrator. Note that disruptions or changes in the channel 1 signal will also affect the integrator.

The full-scale setting of the Model 39 electrometers is also adjustable. There are three full-scale settings, typically 10 pA, 100 pA, and 1000 pA (1 nA). Other settings may exist on specialized units. The scale should be set to whatever range is expected.

A real-time analog display also exists on the units, with a readout as a fraction of full scale (e.g., a reading of 0.1 on the meter, with a full-scale setting of 100 pA, indicates a measured current of 10 pA). Note that the display has a logarithmic scale. The lowest display reading is "0.0001 * full scale."

The electrometer also has an "electronic zero" and "background" setting, each adjustable by a potentiometer ("pot"). For the electrometers at LANSCE, the "background setting" is disabled, and left set at 0.00. The electronic zero is active, and used to provide a sufficient electronic drift on the unit. Sufficient electronic drift (part of the instrument background) is desired to ensure that the system has a positve bias, so no signal will be lost during beam-off situations.

Continued on next page.

Electrometer Test: LANL Model 39, continued

Steps to be performed

To perform the electronic operational test, perform the following steps:

Step	Action
1	Record the as-found integrator reading on the Electrometer Performance Test worksheet. If part of a stack system, record this value in the Stack Log book and Stack Report Form, along with a note that the electronic test is being performed.
2	Mark on the chart paper that an electrometer test is beginning.
3	Record the electrometer readout on the Electrometer Performance Test Work Sheet. This value should represent the “background” current. If not, record value in “comments” section as “starting conditions.”
4	Record the full-scale setting and the electronic zero setting on the worksheet. The “background setting” should be inoperative for the LANSCE electrometers and set to 0.00. If required (to obtain a positive electronic drift), the electronic zero setting can be changed. However, this requires that the entire test be repeated following the change. If multiple full-scale settings are to be tested, repeat the steps in this chapter for each desired setting (mulitple worksheets may be required).
5	Disconnect the input cable from the ion chamber to the pre-amplifier.
6	Plug in the current source, if needed. With the current source turned OFF or in “standby,” connect its cable to the pre-amplifier.
7	Test the connection by adjusting the current source to a level of about 10%-50% of full scale and switching the current source “on.” The electrometer should respond immediately. This test value does not need to be recorded.
8	Set the integrator’s “run/stop” switch to “stop,” and reset the integrator.
9	Adjust the current source output to the desired level (on the worksheet) and verify the source is turned “on.” Note: For “zero input” runs, the current source can be set to zero, or the source can simply be turned to “off” or “standby.”
10	Wait for the electrometer output to stabilize. This can be noted when the output voltages (as displayed on the chart recorder) are constant for 10 seconds or more.

Steps continued on next page.

Electrometer Test: LANL Model 39, continued

Step	Action
11	Simultaneously, switch the integrator to “run” and start the stopwatch.
12	The source should be allowed to run for at least 100 seconds, and longer for zero-input runs and when input current is near background levels. A background run of at least 1000 seconds is recommended.
13	At the completion of the desired run time, simultaneously turn the integrator to “stop” and stop the stopwatch.
14	Record the time interval (in seconds) and the integrator reading (in picocoulombs) on the worksheet, in the appropriate columns.
15	The “measured current” is equal to the charge (pC) divided by the time (seconds). Calcualte and record this value in the appropriate column.
16	Record the electrometer output voltage, displayed on the chart recorder, in the appropriate column(s).
17	If so equipped, record the electronic data logger reading in the appropriate column.
18	Reset the integrator.
19	Repeat steps 9 – 18 for all other desired current values.
20	When all values are completed, re-connect the ion chamber output to the the preamp. The system should be in its “operational” setup now.
21	Measure the post-test background current using the signal from the ion chamber, a time interval of at least 1000 seconds, and methods described in steps 11 – 18. This will be the “background” value used in later analyses.
22	Reset the integrator and switch the integrator to “run.” Note the time.
23	Record this time of reset and integrator reading (zero pC) on the worksheet and, if applicable, in the Stack Logbook and Stack Report Form.
24	Mark on the chart paper that the performance test has ended.

Electrometer Test: Other Models

Background

This test determines the response of the Kanne chamber (KC) electronics package to a known current over its entire operating range. This measurement will require the use of the Keithley Model 263 Calibrator/Current source, or similar calibrated current source. The procedural steps assume any electrometer model that is NOT a LANL Model 39, and is equipped with a real-time current display and voltage output.

Pre-amplifiers

Instructions in this chapter assume that there is no preamplifier attached to the electrometer unit.

Steps to perform the test

To do the electronic operational test, perform the following steps:

Step	Action
1	Record the as-found electrometer reading (current) on the Electrometer Performance Worksheet, in the "Starting Conditions" section. If the Kanne system has a log book associated with it, record the as-found value in the log book as well.
2	If the electrometer has an associated chart recorder, note on the chart paper that an electronics performance test is beginning.
3	If applicable, record the electrometer scale setting on the worksheet. If additional scales are to be tested, repeat the steps in this chapter for the other scales (multiple worksheets may be required).
4	Record the electrometer readout on the Electrometer Performance Test Work Sheet. This value should represent the "background" current. If not, record value in "comments" section as "starting conditions."
5	Plug in the current source (if required).
6	If the electrometer has a "zero check" or "reset" button, activate or hold this button in while changing input connections on the electrometer. This will minimize radical changes in the electrometer input current.
7	Disconnect the input cable from the ion chamber to the electrometer.
8	Connect the current source output to the electrometer input. Adaptors may be necessary, but should be located with the electrometer.

Steps continued on next page.

Electrometer Test: Other Models, continued

Step	Action
9	Test the connection by adjusting the current source to a level of about 10%-50% of full scale, switching the current source "on," and taking the electrometer out of "zero check" or releasing the "reset" button. The electrometer should respond immediately. This test value does not need to be recorded.
10	Adjust the current source output to the desired level (on the worksheet) and verify the source is turned "on." Note: For "zero input" runs, the current source can be set to zero, or the source can simply be turned to "off" or "standby."
11	Wait for the electrometer output to stabilize. This can be noted when the output voltages (as displayed on the chart recorder) are constant for 10 seconds or more.
12	When the electrometer has stabilized, record the electrometer current on the worksheet, in the "measured current" column. The time interval and pC collected columns may be ignored for this test.
13	Record the electrometer output voltage, displayed on the chart recorder, in the appropriate column(s).
14	If so equipped, record the electronic data logger reading in the appropriate column.
15	Repeat steps 10 – 14 for all other desired current values.
16	When all values are completed, re-connect the ion chamber output to the the electrometer (using the "reset" or "zero check" if equipped). The system should be in its "operational" setup now.
17	Measure the post-test background current. Record on the worksheet. This will be the "background" value used in later analyses.
18	Record this time of test completion on the worksheet and, if applicable, in the appropriate log book.
19	Mark on the chart paper that the performance test has ended.

External Source Performance Test

Background

The external source performance test is used to test the entire system response as a trouble-shooting mechanism. This test uses either a ^{60}Co or ^{137}Cs (greater than 50 microcurie) source to induce ionization events inside the Kanne ion chamber. These ionization events generate a current in the chamber, which is measured by the electrometer. There is no set passing value for this measurement, only that the source is significantly detectable above background levels.

For ALARA considerations, this external source test may be conducted on multiple Kanne chamber systems back-to-back, rather than on individual systems at the conclusion of the elctronics test. If so, this may entail conducting the source test on a different day from the rest of the performance test. The date of the external source test should be documented on the worksheet if it is different from the rest of the performance test.

Steps to perform the test

To perform the external performance test, do the following:

Step	Action
1	Retrieve either the ^{60}Co or ^{137}Cs source from the Health Physics Field Office (in MPF 394) and proceed to the Kanne chamber of interest. (**CAUTION:** Observe the three rules of ALARA {time, distance, and shielding} when handling these sources.)
2	Keep the source in sight and keep others away from it. Keep it more than 20 feet from the ion chamber.
3	Record the electrometer reading, with no source near the ion chamber, on the worksheet..
4	Place the source against the side of the ion chamber near the center.
5	Record the electrometer reading on the worksheet.
6	If the system fails the test (no noticeable current difference), troubleshoot the system and repeat the test. Continued failure of the test may require repair or replacement of the Kanne chamber or electrometer.
7	If the Kanne chamber system is equipped with a log book, document the date, time, and results of the test in the log book.
8	If the Kanne chamber system is equipped with a chart recorder, document on the chart the date, time, and the fact that a source test is being conducted.
9	Return the source to the ESH-1/TA53 Field Office.

Backup Battery Test: LANL Model 39

Background

The LANL Model 39 electrometer is equipped with a battery backup system that will function, when new, for more than 4 hours when no external power is being supplied. This feature is useful to prevent loss of data for short power interruptions.

These systems are tested on the stack Kanne Chamber systems only; other systems do not need this level of backup.

If a stack system uses a vendor-supplied Uninterruptable Power Supply in addition to or instead of the Model 39 battery backup, it should be tested in a similar manner. See the vendor literature for more information.

Steps to be performed

To perform the battery performance test, perform the following steps:

Step	Action
1	Document the start of this test in the Stack Log Book and on the Chart Recorder chart paper.
2	Record the integrator reading (if a Model 39 electrometer is used) in the Stack Log Book and on the Stack Report Form.
3	Disconnect the cord between the battery pack and the AC outlet. **Warning**: DO NOT disconnect the power cord that runs between the battery pack and the electrometer.
4	Observe the electrometer display and the chart recorder; no abnormal instability should be present. If this instability is present, there is a problem with the battery supply. Immediately reconnect the power cord; the system will not properly function on battery power. Initiate a deficiency/nonconformance report to address the situation. If no instability is present, the battery test may proceed.
5	Post a note on the Kanne chamber's electrometer that indicates that a battery test is being performed and will continue for the next 24 hours.
6	Observe the chart recorder and electrometer display every two hours or so until: a) the system has stopped, b) the UPS charge indicator indicates very little charge remaining, c) at least 24 hours has elapsed, or d) instability in the system appears. Any of these conditions indicate a completion of the battery test.

Steps continued on next page.

Backup Battery Test: LANL Model 39, continued

Step	Action
7	Reconnect AC power to the electrometer. (It will take a few minutes to hours before the system has charged enough to begin operation again.)
8	If the system had stopped or become unstable, determine the battery life from the chart recorder's paper. Record this value on the worksheet. If the system is OK at the end of the test, note the time inteval that the system lasted (e.g., "> 6 hours") and record it on the worksheet.
9	Remove all posting and record the test results in the Stack Log Book.
10	If the batteries have lasted at least 2 hours, the system has passed the test. Record the result on the Electrometer Performance Test worksheet.
11	If the electrometer tests have already been performed AND the electrometer systems either stopped or became unstable, re-determine "post-test" background for the electrometer as described in earlier chapters.

Records resulting from this procedure

Records

The following records generated as a result of this procedure are to be submitted as records and filed in the Stack Gas Studies notebook for the current year by the assigned staff member:

- Electrometer Response Work Sheet
- all calibration certificates, raw data, notes, calculations, graphs, and final results

HAZARD CONTROL PLAN

1. The work to be performed is described in this procedure.

"Performance Testing of the Kanne Air Flow-Through Ionization Chambers"

2. Describe potential hazards associated with the work (use continuation page if needed).

All hazards as described in HCP-ESH-17-TA53-XA, as supplemented and superseded by:
1) Radiological hazards - contamination on internal components of sample systems is possible
2) hand tools - nicks, cuts, bruises from using tools
3) electrical
   a) Kanne ionization chambers have 300 VDC batteries as power supplies
   b) chart recorders are AC powered and have associated DC voltage signals (less than 10 VDC)

.

3. For each hazard, list the likelihood and severity, and the resulting initial risk level (before any work controls are applied, as determined according to LIR300-00-01.0, section 7.2)

1) Rad: occasional / negligible = Minimal
2) hand tools: occasional / moderate = Low
3) Electrical:
   a) batteries - occasional / moderate = Low
   c) chart recorders - occasional / moderate = Low

Overall *initial* risk: ☐ Minimal ☒ Low ☐ Medium ☐ High

4. Applicable Laboratory, facility, or activity operational requirements directly related to the work:

☒ None ☐ List: Work Permits required? ☐ No ☒ List:

No Radiological work permit is required for routine replacement of sample system components, due to historical process knowledge & controls in applicable procedures. Consult with TA-53 ESH-1 (667-7069) for applicability of RWP to other work on sample systems (pulling probes, cutting into lines, etc).

HAZARD CONTROL PLAN, continued

5. Describe how the hazards listed above will be mitigated (e.g., safety equipment, administrative controls, etc.):

1) radiological - wear gloves (or other PPE as recommended by ESH-1) prior to handling anything that has been exposed to the emissions air stream. Have all such components reviewed by ESH-1 prior to removal from any controlled area.
2) hand tools - use common sense and work in a calm, unhurried fashion.
3) Electrical –
   a) for batteries, handle with care. Isolate batteries behind shield during normal operations.
   b) never work on live AC circuits, always isolate power supplies prior to work on systems. Isolate DC power supplies prior to handling circuitry.

6. Knowledge, skills, abilities, and training necessary to safely perform this work (check one or both):

☒ Group-level orientation (per ESH-17-032) and training to this procedure.

☒ Other → See training prerequisites on procedure page 3. Any additional describe here:

All as stated in HCP-ESH-17-HCP-XA, as supplemented and superseded by this HCP.

7. Any wastes and/or residual materials? (check one) ☐ None ☒ List:

Used batteries may be disposed of in normal trash (per instructions from Eveready representative). If oil is spilled from sampling pump, contact JCNNM (Carlos Tapia, 7-5850) for assistance.

8. Considering the administrative and engineering controls to be used, the *residual* risk level (as determined according to LIR300-00-01.0, section 7.3.3) is (check one):

☐ Minimal ☒ Low ☐ Medium (requires approval by Division Director)

9. Emergency actions to take in event of control failures or abnormal operation (check one):

☐ None ☒ List:

During LANSCE accelerator operation, the Central Control Room (CCR) and ESH-1 offices are staffed 24 hours, 7 days. Contact these offices for assistance as needed.

CCR: 667-5729; Building 4, room 203.

ESH-1 Field Office: 667-7069, Building 395, room 101.

Signature of preparer of this HCP: This HCP was prepared by a knowledgeable individual and reviewed in accordance with requirements in LIR 300-00-01 and LIR 300-00-02.

________________________	________________________	____________
Preparer(s) signature(s)	Name(s) (print) /Position	Date

Signature by group leader on procedure title page signifies authorization to perform work for personnel properly trained to this procedure. This authorization will be renewed annually and documented in ESH-17 records. Controlled copies are considered authorized. Work will be performed to controlled copies only. This plan and procedure will be revised according to ESH-17-022 and distributed according to ESH-17-030.

ESH-17 Air Quality Group

ELECTROMETER PERFORMANCE TEST WORKSHEET

This form is from ESH-17-604

Location:	Test Date:	Reason for Test:
Current Source:	Instrument Calibration Expiration Dates: Flow Nozzle:	Pressure Gauge:
Electrometer ID:	Pre-Amp #:	Electrometer Type:

External Source Test: (PASS / FAIL) Current w/out source: _________ pA Current with source: __________ pA	Battery Endurance Test: (PASS / FAIL / N/A) Total Hours: ___________ High-Voltage Battery: _________ Volts DC OK / Replaced
Pre-Test Background Current:	98% Linearity Test: PASS / FAIL / N/A
Model 39 Settings Electronic Zero: ___________ Background Setting: ___________ Full-Scale Setpoint: ___________	COMMENTS / ADJUSTMENTS _____________________ _____________________ _____________________

CURRENT SOURCE MEASUREMENTS

Current Source output	Elapsed Time (sec)	Charge Collected (pC)	Electrometer Current (pA= pC/sec)	Chart Recorder Volts	EPICS/DataScan Readout
0 pA					
0.1 pA					
0.3 pA					
0.5 pA					
0.7 pA					
1.0 pA					
3.0 pA					
5.0 pA					
7.0 pA					
10.0 pA					
30.0 pA					
50.0 pA					
70.0 pA					
0.1 nA					
0.3 nA					
0.5 nA					
0.7 nA					
1.0 nA					
Post-Test Background					

Time of test beginning: | Time of test completion:

Measurements by:

_______________________ _______________________ _____/_____/_____
Signature | Print name | Date

Reviewed by: (checked for data within expected ranges, all expected data recorded)

_______________________ _______________________ _____/_____/_____
Signature | Print name | Date

ESH-17 Air Quality Group

ELECTROMETER PERFORMANCE TEST WORKSHEET

This form is from ESH-17-604

Location:	Test Date:	Reason for Test:

Instrument Calibration Expiration Dates:

Current Source:	Flow Nozzle:	Pressure Gauge:

Electrometer ID:	Pre-Amp #:	Electrometer Type:

External Source Test: (PASS / FAIL)

Current w/out source: _________ pA

Current with source: __________ pA

Battery Endurance Test: (PASS / FAIL / N/A)

Total Hours: ___________

High-Voltage Battery: _________ Volts DC

OK / Replaced

Pre-Test Background Current:

98% Linearity Test:

PASS / FAIL / N/A

Model 39 Settings

Electronic Zero: ___________

Background Setting: ___________

Full-Scale Setpoint: ___________

COMMENTS / ADJUSTMENTS

____

____

____

CURRENT SOURCE MEASUREMENTS

Current Source output	Elapsed Time (sec)	Charge Collected (pC)	Electrometer Current (pA= pC/sec)	Chart Recorder Volts	EPICS/DataScan Readout
0 pA					
0.1 pA					
0.3 pA					
0.5 pA					
0.7 pA					
1.0 pA					
3.0 pA					
5.0 pA					
7.0 pA					
10.0 pA					
30.0 pA					
50.0 pA					
70.0 pA					
0.1 nA					
0.3 nA					
0.5 nA					
0.7 nA					
1.0 nA					
Post-Test Background					

Time of test beginning:	Time of test completion:

Measurements by:

______________________________ ______________________________ _____/_____/_____

Signature Print name Date

Reviewed by: (checked for data within expected ranges, all expected data recorded)

______________________________ ______________________________ _____/_____/_____

Signature Print name Date